PATENT ABSTRACTS OF JAPAN

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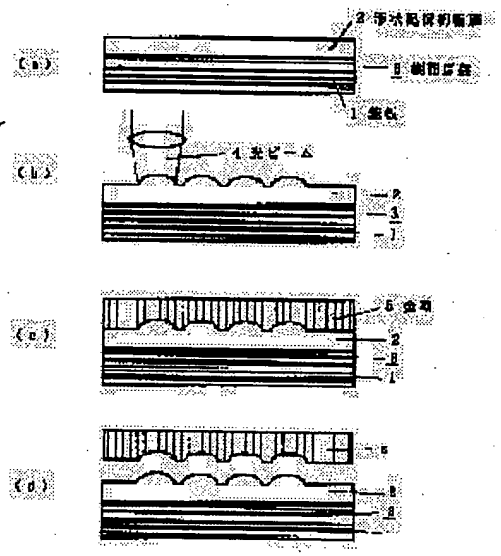
(54) MANUFACTURE OF MOLD FOR MICROLENS ARRAY AND MATRIX FOR THE MICROLENS ARRAY

(57)Abstract:
PROBLEM TO BE SOLVED: To make it possible to manufacture a microlens array in a short time by forming a shape memory resin film containing a light absorber, selectively emitting an optical beam to the obtained resin matrix to form a semispherical pattern, and forming metal film on the surface to obtain a mold.
SOLUTION: A substrate 1 is coated with solution that light absorber and shape memory resin are dispersed or dissolved in solvent, dried to form a shape memory resin layer 2, heated to a transition temperature or higher, and then cooled to fix and store the initial shape to obtain a resin matrix 3. Then, an optical beam 4 having a predetermined wavelength is emitted, heated from a temperature of the transition temperature or lower of solid phase to the transition temperature or higher of reversible phase, and deformation is given. This operation is so repeated by moving the beam 4 or the matrix 3 as to form a desired pattern, thereby obtaining the matrix 3 formed with the desired pattern. A conductive film of nickel is formed on the pattern surface of the matrix 3 by sputtering, and Ni electroformed to obtain a mold 5 transferred with the pattern.



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JAPANESE [JP,09-076245,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] the micro-lens array characterized by to consist of the process which obtains the metal mold which imprinted said pattern by forming a metal on the process which forms on a substrate the shape-memory resin film which made light-absorption material contain, and obtains resin original recording, the process which irradiates a light beam alternatively at said resin original recording, and form a semi-sphere-like pattern in the front face of said shape-memory resin film, and the front face in which said pattern was formed — public funds — the manufacture approach of a mold.
[Claim 2] Original recording for micro-lens arrays characterized by providing a substrate with a smooth front face, and the shape-memory resin layer in which the semi-sphere-like pattern was formed by heating.
[Claim 3] It is the original recording for micro-lens arrays characterized by being the original recording for micro-lens arrays according to claim 2, and said shape-memory resin layer containing the light absorption material which absorbs a light beam.
[Claim 4] Original recording for micro-lens arrays characterized by being the original recording for micro-lens arrays according to claim 2 to 3, and said shape-memory resin being thermosetting polyurethane resin.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the manufacture approach of a micro-lens array used for a liquid crystal display component, a solid state image sensor, etc.
[0002]
[Description of the Prior Art] A micro-lens array distributes the lens of the minute shape of a semi-sphere of the diameter of several micrometers - 100 micrometers of numbers, and since the effect by black matrices, such as a liquid crystal display, is lost and brightness is increased, it is used.
[0003] The micro-lens array arranged single dimension-wise [the lens of the shape of a minute semi-sphere] or two-dimensional has a complicated configuration, and since magnitude is detailed, it is difficult to obtain the metal mold by mechanical processing.
[0004] Therefore, the dry etching method for forming a semi-sphere-like pattern on a substrate, producing original recording, producing metal mold from this original recording, fabricating resin, and obtaining a micro-lens array is used by installing the mask with which opening was formed on substrates, such as silicon, and giving dry etching within vacuum devices conventionally.
[0005] Moreover, a developer is applied after making the resin original recording in which photopolymers, such as a photoresist, were formed on substrates, such as a metal, expose a photopolymer by irradiating a light beam. By contacting the substrate of a part from which the exposed part was removed and the photopolymer was removed to a predetermined time amount etching reagent, and performing wet etching The wet etching method which forms a semi-sphere-like hole in a substrate, produces original recording, produces metal mold from this original recording, fabricates resin, and fabricates a micro-lens array is used.
[0006]
[Problem(s) to be Solved by the Invention] However, in order to etch a substrate using the dry etching method, the etching time of long duration was required, and it was difficult to form a uniform pattern over a large area. Furthermore, there was a case where chlorine-based gas harmful to the body as etching gas was used.
[0007] Moreover, in order to etch a substrate using the wet etching method, very dangerous solvents, such as fluoric acid, had to be used as an etching reagent. Moreover, the etching time of long duration was required like the dry etching method.
[0008] Furthermore, when the original recording which formed a certain pattern once was reused, the front face in which the pattern was formed had to be ground and the long time was spent on the time amount to grind. Moreover, when board thickness used a thin substrate, reuse by polish was not completed.
[0009]
[Means for Solving the Problem] In the manufacture approach of a mold invention of this invention according to claim 1 — setting — a micro-lens array — public funds — The process which forms on a substrate the shape-memory resin film which made light absorption material contain, and obtains resin original recording, It is characterized by providing the process which obtains the metal mold which imprinted the pattern by forming a metal on the process which irradiates a light beam alternatively at resin original recording, and forms a semi-sphere-like pattern in the front face of the shape-memory resin film, and the front face in which the pattern was formed.
[0010] In invention of this invention according to claim 2, it is characterized by providing a substrate with a smooth front face, and the shape-memory resin layer in which the semi-sphere-like pattern was formed by heating in the original recording for micro-lens arrays.
[0011] In invention of this invention according to claim 3, it is the original recording for micro-lens arrays according to claim 2, and is characterized by said shape-memory resin layer containing the light absorption material which absorbs a light beam.
[0012] In invention of this invention according to claim 4, it is the original recording for micro-lens arrays according to claim 2 to 3, and is characterized by a shape-memory resin being thermosetting polyurethane resin.
[0013] this invention — a micro-lens array — public funds — the resin original recording which formed on the substrate the shape-memory resin layer which consists of the thermosetting polyurethane resin which made light absorption material, such as organic coloring matter, contain, the styrene butadiene copolymer resin, poly norbornene resin, etc. as original recording for micro-lens arrays used for the manufacture approach of a mold is used.
[0014] If a light beam is irradiated by the predetermined pattern at the shape-memory resin layer which made light

absorption material contain, the light absorption material which exists in the part by which the light beam was irradiated absorbs a light beam, a shape-memory resin can be heated, thermal expansion can be carried out to the shape of a semi-sphere side, and the resin original recording which has the same pattern as a desired micro-lens array can be obtained.
[0015] And by electroforming metals, such as nickel (nickel), the metal mold which imprinted the pattern of a micro-lens array is produced, using this metal mold, the resin which has a desired optical property can be cast on the front face of this resin original recording, and a micro-lens array can be produced on it.
[0016]
[Embodiment of the Invention] The manufacture approach of the metal mold for micro-lens arrays of this invention uses the resin original recording in which shape-memory resin layers, such as thermosetting polyurethane resin which made light absorption material, such as organic coloring matter, contain, styrene butadiene copolymer resin, and poly norbornene resin, were formed on the substrate, as original recording for micro-lens arrays.
[0017] To the wavelength of a light beam, shape-memory resins, such as thermosetting polyurethane resin, styrene butadiene copolymer resin, and poly norbornene resin, are transparent, and have an reversible phase and a solid-state phase. The light absorption material which absorbs a light beam and raises the temperature of resin into this shape-memory resin contains.
[0018] Light absorption material is used choosing it from organic coloring matter, such as the ingredient which has the capacity which absorbs a light beam in the wavelength region of the light beam to be used, and distributes or dissolves into a shape-memory resin, for example, cyanines, phthalocyanines, dithiols, and diamines.
[0019] Shape-memory resins, such as thermosetting polyurethane resin, styrene butadiene copolymer resin, and poly norbornene resin, consist of an reversible phase which had the change-of-state function which repeats hardening and softening reversibly in the macromolecule chain, and a stationary phase with the fixed point which fixes the physical relationship of a macromolecule.
[0020] An reversible phase has the transition temperature T1 from which an elastic modulus changes a lot to a temperature change, and, on the other hand, the stationary phase has the transition temperature T2 (T2> T1) which is the fixed points, such as bridge formation of a macromolecule chain, and a tangle.
[0021] next, the micro-lens array of this invention — public funds — the manufacture approach of a mold is explained to a detail using a drawing. drawing 1 — the micro-lens array of this invention — public funds — it is the mimetic diagram having shown the production process of the manufacture approach of a mold. The process at which the process in which the process at which drawing 1 (a) produces resin original recording, and drawing 1 (b) form the pattern of a micro-lens array, and drawing 1 (c) produce metal mold, and drawing 1 (d) show the process which exfoliates metal mold. moreover, the micro-lens array from which drawing 2 was obtained by the manufacture approach of this invention — public funds — it is the mimetic diagram having shown the production process which fabricates a micro-lens array using a mold. The process at which drawing 2 (a) fabricates a micro-lens array, and drawing 2 (b) show the process which exfoliates a micro-lens array from metal mold.
[0022] First, by applying to light beam wavelength the solution made to distribute or dissolve the light absorption material which has an absorption band region, and a shape-memory resin in a solvent, drying it, forming the shape-memory resin layer 2 on the substrates 1, such as glass and silicon, heating more than [of the stationary phase of a shape-memory resin] transition-temperature T2, and cooling, the first configuration is made to fix and memorize and the resin original recording 3 is obtained (drawing 1 (a)).
[0023] Next, the light beam 4 of wavelength predetermined to the shape-memory resin layer 2 is irradiated, and is heated to the temperature not more than transition-temperature T2 of a stationary phase more than by transition-temperature T1 of an reversible phase, and deformation is given. Light absorption material absorbs a light beam 4, generates heat, and it expands while an reversible phase is heated and softening. When the light beam 4 was intercepted, while the shape-memory resin layer 2 was cooled immediately, it quenched upheaval of the shape of a semi-sphere made by thermal expansion and deformation had been held, it returns to a room temperature.
[0024] The resin original recording 3 in which the desired pattern was formed is obtained by moving a light beam 4 or the resin original recording 3, and repeating so that a desired pattern may be formed for this actuation (drawing 1 (b)).
[0025] Then, electric conduction film, such as nickel (nickel), is formed in the pattern front face of the resin original recording 3 in which the desired pattern was formed by sputtering etc., nickel electrocasting is performed after that, and the metal mold 5 which imprinted the pattern is obtained (drawing 1 (c)).
[0026] And metal mold 5 is exfoliated from the resin original recording 3 (drawing 1 (d)), using metal mold 5, the resin or glass which has a desired refractive index can be fabricated by approaches, such as an injection-molding method and 2P (Photo Polymer) law, (drawing 2 (a)), and the micro-lens array 6 can be obtained by removing from metal mold 5 (drawing 2 (b)).
[0027] If the resin original recording 3 which removed metal mold 5 is installed in oven etc. and is finally heated and annealed to the temperature not more than transition-temperature T2 of a stationary phase more than by transition-temperature T1 of an reversible phase, in order to remove residual internal stress, deformation is opened wide, and it can recover and reuse in the smooth configuration of the origin which the stationary phase memorized.
[0028]
[Example] the following — the micro-lens array of this invention — public funds — the example of the manufacture approach of a mold is shown in a detail. Although this example shows the case where thermosetting polyurethane resin is used as an example of a shape-memory resin, when the shape-memory resin of others, such as styrene

butadiene copolymer resin and poly norbornene resin, is used, it is also the same as that of the example essentially shown below. The thermosetting polyurethane resin solution filtered with the 0.5-micrometer filter was applied to the glass substrate front face with a thickness of 6mm washed by 3000rpm with the spin coating method, the thermosetting polyurethane resin layer with a thickness of 7 micrometers was formed in it, and resin original recording was produced.

[0029] Here, the thermosetting polyurethane resin solution mixed and produced the matter shown below. Moreover, in order to make a laser beam with a wavelength of 780nm absorb, the organic coloring matter which has an absorption band in this wavelength region was mixed as light absorption material.

Thermosetting polyurethane resin (Sanyo Chemical Industries make: SAMPUREN, 30% solution of resin concentration) 36.9wt% Curing agent (Sanyo Chemical Industries make: CA075N, isocyanate system cross linking agent) 1.2wt% Organic coloring matter (Nippon Kasei Chemical make: IRG-003) 1.2wt% Tetrachloroethane 60.7wt%

[0030] On the resin original recording which consists of the above presentation, the laser beam with a wavelength of 780nm was narrowed down to the beam diameter of 15 micrometers, it adjusted so that the output in a resin original recording front face might be set to 30mW, and when [of 1ms] the time amount exposure was carried out, the micro-lens pattern of the shape of a semi-sphere with a diameter [of about 10 micrometers] and a height of about 3 micrometers was formed. And the laser beam was moved, above-mentioned actuation was repeated, and the pattern of a micro-lens array was formed on resin original recording.

[0031] nickel film was formed in the front face of the resin original recording in which the above-mentioned pattern was formed at 0.1-micrometer thickness, then nickel electrocasting was performed, and metal mold with a thickness of about 5mm which imprinted the above-mentioned pattern was produced.

[0032] Next, the micro-lens array was produced by 2P law using the obtained metal mold. Ultraviolet rays were irradiated and the photopolymer was stiffened, after dropping a photopolymer at metal mold, installing a soda glass substrate and extending a photopolymer to homogeneity. Then, when it exfoliated from metal mold, the uniform micro-lens array has been formed on the soda glass substrate.

[0033] When the magnitude of the micro lens of the obtained micro-lens array was measured under the microscope between atomic energy, it is about 3 micrometers in the diameter of about 10 micrometers, and height, and imprinted faithfully from metal mold. When this micro-lens array was installed in the liquid crystal panel, the brightness of a screen increased 1.3 times.

[0034] Moreover, when the resin original recording after removing metal mold was installed in oven and heated for 1 minute at 80 degrees C, the pattern of a micro-lens array disappeared and it recovered in the original smooth condition.

[0035]

[Effect of the Invention] as mentioned above, the micro-lens array of this invention — public funds — like the conventional manufacture approach, since the processes, such as a dry etching process and a wet etching process, are unnecessary, a micro lens can be produced in a short time, and it is not necessary to use dangerous gas and a dangerous solvent by the manufacture approach of a mold

[0036] furthermore, the micro-lens array of this invention — public funds — by the manufacture approach of a mold The original recording which uses the resin original recording in which shape-memory resin layers, such as thermosetting polyurethane resin which made light absorption material, such as organic coloring matter, contain, were formed, as original recording for micro-lens arrays and by which the pattern was once formed on the substrate a short time and only by heating since a pattern can be eliminated and still more nearly another pattern can be formed — two or more micro-lens arrays from one original recording for micro-lens arrays — public funds — a mold is producible.

[Translation done.]

TECHNICAL FIELD

[The technical field to which invention belongs] This invention relates to the manufacture approach of a micro-lens array used for a liquid crystal display component, a solid state image sensor, etc.

[Translation done.]

PRIOR ART

[Description of the Prior Art] A micro-lens array distributes the lens of the minute shape of a semi-sphere of the diameter of several micrometers - 100 micrometers of numbers, and since the effect by black matrices, such as a liquid crystal display, is lost and brightness is increased, it is used.
[0003] The micro-lens array arranged single dimension-wise [the lens of the shape of a minute semi-sphere] or two-dimensional has a complicated configuration, and since magnitude is detailed, it is difficult to obtain the metal mold by mechanical processing.
[0004] Therefore, the dry etching method for forming a semi-sphere-like pattern on a substrate, producing original recording, producing metal mold from this original recording, fabricating resin, and obtaining a micro-lens array is used by installing the mask with which opening was formed on substrates, such as silicon, and giving dry etching within vacuum devices conventionally.
[0005] Moreover, a developer is applied after making the resin original recording in which photopolymers, such as a photoresist, were formed on substrates, such as a metal, expose a photopolymer by irradiating a light beam, The wet etching method which forms a semi-sphere-like hole in a substrate, produces original recording, produces metal mold from this original recording, fabricates resin, and fabricates a micro-lens array is used by contacting the substrate of a part from which the exposed part was removed and the photopolymer was removed to a predetermined time amount etching reagent, and performing wet etching.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] as mentioned above, the micro-lens array of this invention — public funds — like the conventional manufacture approach, since the processes, such as a dry etching process and a wet etching process, are unnecessary, a micro lens can be produced in a short time, and it is not necessary to use dangerous gas and a dangerous solvent by the manufacture approach of a mold
[0036] furthermore, the micro-lens array of this invention — public funds — the manufacture approach of a mold since the resin original recording in which shape-memory resin layers, such as thermosetting polyurethane resin which made light absorption material, such as organic coloring matter, contain, were formed is used as original recording for micro-lens arrays on the substrate, a pattern can be eliminated for the original recording in which the pattern was formed once a short time and only by heating and still more nearly another pattern can be formed — two or more micro-lens arrays from one original recording for micro-lens arrays — public funds — a mold is producible.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in order to etch a substrate using the dry etching method, the etching time of long duration was required, and it was difficult to form a uniform pattern over a large area. Furthermore, there was a case where chlorine-based gas harmful to the body as etching gas was used.
[0007] Moreover, in order to etch a substrate using the wet etching method, very dangerous solvents, such as fluoric acid, had to be used as an etching reagent. Moreover, the etching time of long duration was required like the dry etching method.
[0008] Furthermore, when the original recording which formed a certain pattern once was reused, the front face in which the pattern was formed had to be ground and the long time was spent on the time amount to grind. Moreover, when board thickness used a thin substrate, reuse by polish was not completed.

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MEANS

[Means for Solving the Problem] In the manufacture approach of a mold invention of this invention according to claim 1 — setting — a micro-lens array — public funds — The process which forms on a substrate the shape-memory resin film which made light absorption material contain, and obtains resin original recording, It is characterized by providing the process which obtains the metal mold which imprinted the pattern by forming a metal on the process which irradiates a light beam alternatively at resin original recording, and forms a semi-sphere-like pattern in the front face of the shape-memory resin film, and the front face in which the pattern was formed.
[0010] In invention of this invention according to claim 2, it is characterized by providing a substrate with a smooth front face, and the shape-memory resin layer in which the semi-sphere-like pattern was formed by heating in the original recording for micro-lens arrays.
[0011] In invention of this invention according to claim 3, it is the original recording for micro-lens arrays according to claim 2, and is characterized by said shape-memory resin layer containing the light absorption material which absorbs a light beam.
[0012] In invention of this invention according to claim 4, it is the original recording for micro-lens arrays according to claim 2 to 3, and is characterized by a shape-memory resin being thermosetting polyurethane resin.
[0013] this invention — a micro-lens array — public funds — the resin original recording which formed on the substrate the shape-memory resin layer which consists of the thermosetting polyurethane resin which made light absorption material, such as organic coloring matter, contain, the styrene butadiene copolymer resin, poly norbornene resin, etc. as original recording for micro-lens arrays used for the manufacture approach of a mold is used.
[0014] If a light beam is irradiated by the predetermined pattern at the shape-memory resin layer which made light absorption material contain, the light absorption material which exists in the part by which the light beam was irradiated absorbs a light beam, a shape-memory resin can be heated, thermal expansion can be carried out to the shape of a semi-sphere side, and the resin original recording which has the same pattern as a desired micro-lens array can be obtained.
[0015] And by electroforming metals, such as nickel (nickel), the metal mold which imprinted the pattern of a micro-lens array is produced, using this metal mold, the resin which has a desired optical property can be cast on the front face of this resin original recording, and a micro-lens array can be produced on it.
[0016]
[Embodiment of the Invention] The manufacture approach of the metal mold for micro-lens arrays of this invention uses the resin original recording in which shape-memory resin layers, such as thermosetting polyurethane resin which made light absorption material, such as organic coloring matter, contain, styrene butadiene copolymer resin, and poly norbornene resin, were formed on the substrate, as original recording for micro-lens arrays.
[0017] To the wavelength of a light beam, shape-memory resins, such as thermosetting polyurethane resin, styrene butadiene copolymer resin, and poly norbornene resin, are transparent, and have an reversible phase and a solid-state phase. The light absorption material which absorbs a light beam and raises the temperature of resin into this shape-memory resin contains.
[0018] Light absorption material is used choosing it from organic coloring matter, such as the ingredient which has the capacity which absorbs a light beam in the wavelength region of the light beam to be used, and distributes or dissolves into a shape-memory resin, for example, cyanines, phthalocyanines, dithiols, and diamines.
[0019] Shape-memory resins, such as thermosetting polyurethane resin, styrene butadiene copolymer resin, and poly norbornene resin, consist of an reversible phase which had the change-of-state function which repeats hardening and softening reversibly in the macromolecule chain, and a stationary phase with the fixed point which fixes the physical relationship of a macromolecule.
[0020] An reversible phase has the transition temperature T1 from which an elastic modulus changes a lot to a temperature change, and, on the other hand, the stationary phase has the transition temperature T2 (T2> T1) which is the fixed points, such as bridge formation of a macromolecule chain, and a tangle.
[0021] next, the micro-lens array of this invention — public funds — the manufacture approach of a mold is explained to a detail using a drawing. drawing 1 — the micro-lens array of this invention — public funds — it is the mimetic diagram having shown the production process of the manufacture approach of a mold. The process at which the process in which the process at which drawing 1 (a) produces resin original recording, and drawing 1 (b) form the pattern of a micro-lens array, and drawing 1 (c) produce metal mold, and drawing 1 (d) show the process which exfoliates metal mold. moreover, the micro-lens array from which drawing 2 was obtained by the manufacture

approach of this invention — public funds — it is the mimetic diagram having shown the production process which fabricates a micro-lens array using a mold. The process at which drawing 2 (a) fabricates a micro-lens array, and drawing 2 (b) show the process which exfoliates a micro-lens array from metal mold.

[0022] First, by applying to light beam wavelength the solution made to distribute or dissolve the light absorption material which has an absorption band region, and a shape-memory resin in a solvent, drying it, forming the shape-memory resin layer 2 on the substrates 1, such as glass and silicon, heating more than [of the stationary phase of a shape-memory resin] transition-temperature T2, and cooling, the first configuration is made to fix and memorize and the resin original recording 3 is obtained (drawing 1 (a)).

[0023] Next, the light beam 4 of wavelength predetermined to the shape-memory resin layer 2 is irradiated, and is heated to the temperature not more than transition-temperature T2 of a stationary phase more than by transition-temperature T1 of an reversible phase, and deformation is given. Light absorption material absorbs a light beam 4, generates heat, and it expands while an reversible phase is heated and softening. When the light beam 4 was intercepted, while the shape-memory resin layer 2 was cooled immediately, it quenched upheaval of the shape of a semi-sphere made by thermal expansion and deformation had been held, it returns to a room temperature.

[0024] The resin original recording 3 in which the desired pattern was formed is obtained by moving a light beam 4 or the resin original recording 3, and repeating so that a desired pattern may be formed for this actuation (drawing 1 (b)).

[0025] Then, electric conduction film, such as nickel (nickel), is formed in the pattern front face of the resin original recording 3 in which the desired pattern was formed by sputtering etc., nickel electrocasting is performed after that, and the metal mold 5 which imprinted the pattern is obtained (drawing 1 (c)).

[0026] And metal mold 5 is exfoliated from the resin original recording 3 (drawing 1 (d)), using metal mold 5, the resin or glass which has a desired refractive index can be fabricated by approaches, such as an injection-molding method and 2P (Photo Polymer) law, (drawing 2 (a)), and the micro-lens array 6 can be obtained by removing from metal mold 5 (drawing 2 (b)).

[0027] If the resin original recording 3 which removed metal mold 5 is installed in oven etc. and is finally heated and annealed to the temperature not more than transition-temperature T2 of a stationary phase more than by transition-temperature T1 of an reversible phase, in order to remove residual internal stress, deformation is opened wide, and it can recover and reuse in the smooth configuration of the origin which the stationary phase memorized.

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EXAMPLE

[Example] the following — the micro-lens array of this invention — public funds — the example of the manufacture approach of a mold is shown in a detail. Although this example shows the case where thermosetting polyurethane resin is used as an example of a shape-memory resin, when the shape-memory resin of others, such as styrene butadiene copolymer resin and poly norbornene resin, is used, it is also the same as that of the example essentially shown below. The thermosetting polyurethane resin solution filtered with the 0.5-micrometer filter was applied to the glass substrate front face with a thickness of 6mm washed by 3000rpm with the spin coating method, the thermosetting polyurethane resin layer with a thickness of 7 micrometers was formed in it, and resin original recording was produced.

[0029] Here, the thermosetting polyurethane resin solution mixed and produced the matter shown below. Moreover, in order to make a laser beam with a wavelength of 780nm absorb, the organic coloring matter which has an absorption band in this wavelength region was mixed as light absorption material.

Thermosetting polyurethane resin (Sanyo Chemical Industries make: SAMPUREN, 30% solution of resin concentration) 36.9wt% Curing agent (Sanyo Chemical Industries make: CA075N, isocyanate system cross linking agent) 1.2wt% Organic coloring matter (Nippon Kasei Chemical make: IRG-003) 1.2wt% Tetrachloroethane 60.7wt%

[0030] On the resin original recording which consists of the above presentation, the laser beam with a wavelength of 780nm was narrowed down to the beam diameter of 15 micrometers, it adjusted so that the output in a resin original recording front face might be set to 30mW, and when [of 1ms] the time amount exposure was carried out, the micro-lens pattern of the shape of a semi-sphere with a diameter [of about 10 micrometers] and a height of about 3 micrometers was formed. And the laser beam was moved, above-mentioned actuation was repeated, and the pattern of a micro-lens array was formed on resin original recording.

[0031] nickel film was formed in the front face of the resin original recording in which the above-mentioned pattern was formed at 0.1-micrometer thickness, then nickel electrocasting was performed, and metal mold with a thickness of about 5mm which imprinted the above-mentioned pattern was produced.

[0032] Next, the micro-lens array was produced by 2P law using the obtained metal mold. Ultraviolet rays were irradiated and the photopolymer was stiffened, after dropping a photopolymer at metal mold, installing a soda glass substrate and extending a photopolymer to homogeneity. Then, when it exfoliated from metal mold, the uniform micro-lens array has been formed on the soda glass substrate.

[0033] When the magnitude of the micro lens of the obtained micro-lens array was measured under the microscope between atomic energy, it is about 3 micrometers in the diameter of about 10 micrometers, and height, and imprinted faithfully from metal mold. When this micro-lens array was installed in the liquid crystal panel, the brightness of a screen increased 1.3 times.

[0034] Moreover, when the resin original recording after removing metal mold was installed in oven and heated for 1 minute at 80 degrees C, the pattern of a micro-lens array disappeared and it recovered in the original smooth condition.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The mimetic diagram having shown the production process of the manufacture approach of the metal mold for micro-lens arrays of this invention.
(a) The process which produces resin original recording,
(b) The process which forms the pattern of a micro-lens array
(c) The process which produces metal mold
(d) The process which exfoliates metal mold
[Drawing 2] the micro-lens array obtained by the manufacture approach of this invention — public funds — the mimetic diagram having shown the production process which fabricates a micro-lens array using a mold.
(a) The process which fabricates a micro-lens array
(b) The process which exfoliates a micro-lens array from metal mold
[Description of Notations]
1 Substrate
2 Shape-memory Resin Layer
3 Resin Original Recording
4 Light Beam
5 Metal Mold
6 Micro-Lens Array

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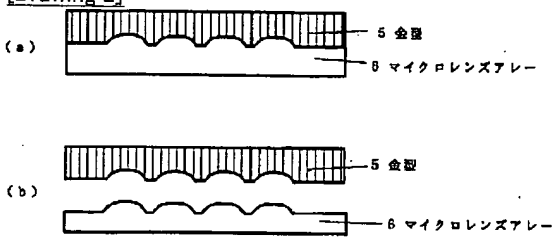
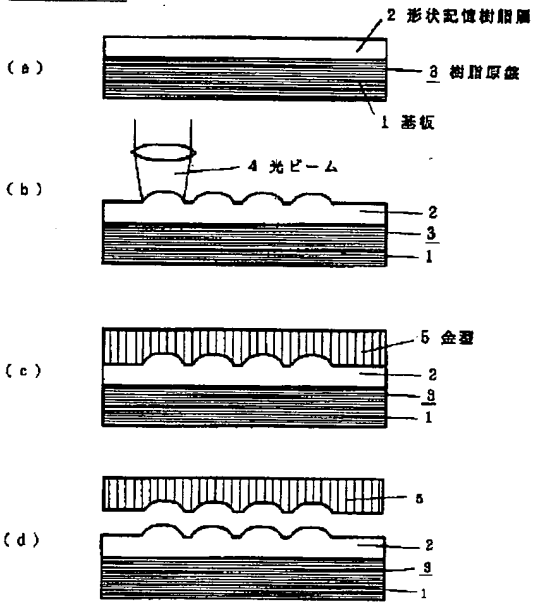
DRAWINGS

[Drawing 2]



[Drawing 1]



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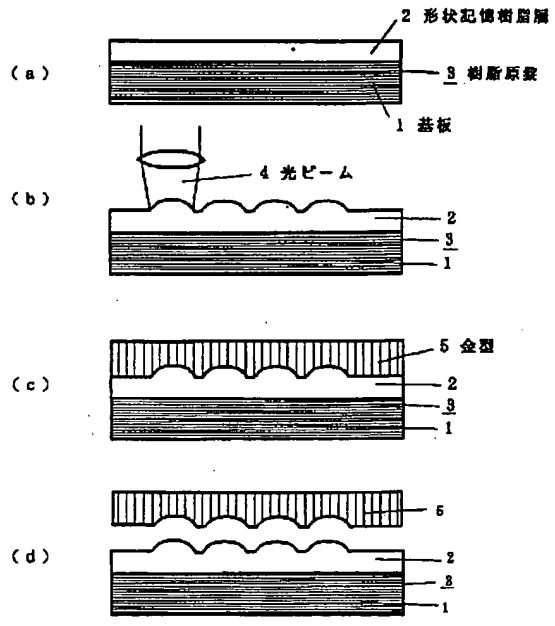
(54)【発明の名称】　マイクロレンズアレー用金型の製造方法及びマイクロレンズアレー用原盤

(57)【要約】

【課題】　従来のドライエッチング法及びウエットエッチング法を用いるマイクロレンズアレー用金型の製造方法は、長時間のエッチング時間が必要であり、また、大面積に渡り均一なパターンを形成することが困難であった。

【解決手段】　基板上に光吸収材を含有させた形状記憶樹脂膜を形成し樹脂原盤を得る工程と、前記樹脂原盤に光ビームを選択的に照射し、前記形状記憶樹脂膜の表面に半球状のパターンを形成する工程と、前記パターンが形成された表面に金属を電鋳することによって前記パターンを転写した金型を得る工程とから成ることを特徴とする。



【特許請求の範囲】
【請求項１】基板上に光吸収材を含有させた形状記憶樹脂膜を形成し樹脂原盤を得る工程と、前記樹脂原盤に光ビームを選択的に照射し前記形状記憶樹脂膜の表面に半球状のパターンを形成する工程と、前記パターンが形成された表面に金属を成膜することによって前記パターンを転写した金型を得る工程とから成ることを特徴とするマイクロレンズアレー用金型の製造方法。
【請求項２】表面が平滑な基板と、加熱により半球状のパターンが形成された形状記憶樹脂層とを具備することを特徴とするマイクロレンズアレー用原盤。
【請求項３】請求項２に記載のマイクロレンズアレー用原盤であって、前記形状記憶樹脂層は光ビームを吸収する光吸収材を含有することを特徴とするマイクロレンズアレー用原盤。
【請求項４】請求項２乃至請求項３記載のマイクロレンズアレー用原盤であって、前記形状記憶樹脂が熱硬化性ポリウレタン樹脂であることを特徴とするマイクロレンズアレー用原盤。
【発明の詳細な説明】
【０００１】
【発明が属する技術分野】本発明は、液晶表示素子や固体撮像素子等に用いるマイクロレンズアレーの製造方法に関するものである。
【０００２】
【従来の技術】マイクロレンズアレーは、直径数μｍ～数１００μｍの微小な半球状のレンズを分布させたものであり、液晶表示等のブラックマトリックスによる影響をなくして明るさを増すためなどに使用されている。
【０００３】微小な半球状のレンズが一次元的あるいは二次元的に配列されたマイクロレンズアレーは、形状が複雑であり、大きさが微細なため、機械的な加工によってその金型を得ることは困難である。
【０００４】そのため、従来は、シリコン等の基板上に開口部が形成されたマスクを設置し、真空装置内でドライエッチングを施すことにより、基板上に半球状のパターンを形成して原盤を作製し、この原盤から金型を作製して樹脂を成形しマイクロレンズアレーを得るドライエッチング法が用いられている。
【０００５】また、金属等の基板上にフォトレジスト等の感光性樹脂を形成した樹脂原盤に、光ビームを照射することにより感光性樹脂を感光させた後、現像液を塗布して、感光した部分を除去し、感光性樹脂が除去された部分の基板を所定の時間エッチング液に接触させてウエットエッチングを行うことにより、基板に半球状の孔を形成して原盤を作製し、この原盤から金型を作製して樹脂を成形してマイクロレンズアレーを成形するウエットエッチング法が用いられている。
【０００６】
【発明が解決しようとする課題】しかしながら、ドライエッチング法を用いて基板をエッチングするためには、長時間のエッチング時間が必要であり、また、大面積に渡り均一なパターンを形成することが困難であった。さらに、エッチングガスとして人体に有害な塩素系ガスを用いる場合があった。
【０００７】また、ウエットエッチング法を用いて基板をエッチングするためには、エッチング液としてフッ酸等の非常に危険な溶剤を用いなくてはならなかった。また、ドライエッチング法と同様に、長時間のエッチング時間が必要であった。
【０００８】さらに、一度あるパターンを形成した原盤を再利用する場合は、パターンが形成された表面を研磨しなくてはならず、研磨する時間に長時間を費やしていた。また、板厚が薄い基板を用いた場合は、研磨による再利用はできなかった。
【０００９】
【課題を解決するための手段】本発明の請求項１記載の発明においては、マイクロレンズアレー用金型の製造方法において、基板上に光吸収材を含有させた形状記憶樹脂膜を形成し樹脂原盤を得る工程と、樹脂原盤に光ビームを選択的に照射し形状記憶樹脂膜の表面に半球状のパターンを形成する工程と、パターンが形成された表面に金属を成膜することによってパターンを転写した金型を得る工程とを具備することを特徴とするものである。
【００１０】本発明の請求項２記載の発明においては、マイクロレンズアレー用原盤において、表面が平滑な基板と、加熱により半球状のパターンが形成された形状記憶樹脂層とを具備することを特徴とするものである。
【００１１】本発明の請求項３記載の発明においては、請求項２に記載のマイクロレンズアレー用原盤であって、前記形状記憶樹脂層は光ビームを吸収する光吸収材を含有することを特徴とするものである。
【００１２】本発明の請求項４記載の発明においては、請求項２乃至請求項３記載のマイクロレンズアレー用原盤であって、形状記憶樹脂が熱硬化性ポリウレタン樹脂であることを特徴とするものである。
【００１３】本発明では、マイクロレンズアレー用金型の製造方法に用いるマイクロレンズアレー用原盤として、基板上に有機色素等の光吸収材を含有させた熱硬化性ポリウレタン樹脂、スチレン－ブタジエン共重合体樹脂、ポリノルボルネン樹脂等から成る形状記憶樹脂層を形成した樹脂原盤を用いる。
【００１４】光吸収材を含有させた形状記憶樹脂層に光ビームを所定のパターンで照射すると、光ビームが照射された部分に存在する光吸収材が光ビームを吸収し、形状記憶樹脂が加熱され半球面状に熱膨張し、所望のマイクロレンズアレーと同じパターンを有する樹脂原盤を得ることができる。
【００１５】そして、この樹脂原盤の表面に、ニッケル（Ｎｉ）等の金属を電鋳することにより、マイクロレン

ズアレーのパターンを転写した金型を作製し、この金型を用いて、所望の光学特性を有する樹脂を成型しマイクロレンズアレーを作製することができる。

【００１６】

【発明の実施の形態】本発明のマイクロレンズアレー用金型の製造方法は、基板上に有機色素等の光吸収材を含有させた熱硬化性ポリウレタン樹脂、スチレン－ブタジエン共重合体樹脂、ポリノルボルネン樹脂等の形状記憶樹脂層を形成した樹脂原盤を、マイクロレンズアレー用原盤として用いる。

【００１７】熱硬化性ポリウレタン樹脂、スチレン－ブタジエン共重合体樹脂、ポリノルボルネン樹脂等の形状記憶樹脂は、光ビームの波長に対し透明であり、可逆相と固体相を有するものである。この形状記憶樹脂中には、光ビームを吸収して樹脂の温度を高める光吸収材が含有されている。

【００１８】光吸収材は、使用する光ビームの波長域において光ビームを吸収する能力を有し、かつ、形状記憶樹脂中に分散あるいは溶解する材料、例えばシアニン類、フタロシアニン類、ジチオール類、ジアミン類等の有機色素の中から選択して使用される。

【００１９】熱硬化性ポリウレタン樹脂、スチレン－ブタジエン共重合体樹脂、ポリノルボルネン樹脂等の形状記憶樹脂は、高分子鎖中に可逆的に硬化と軟化を繰り返す状態変化機能をもった可逆相と、高分子の位置関係を固定する固定点を持った固定相からなるものである。

【００２０】可逆相は、温度変化に対して弾性率が大きく変化する転移温度Ｔ１を有し、一方、固定相は、高分子鎖の架橋、絡み合い等の固定点である転移温度Ｔ２（Ｔ２＞Ｔ１）を有している。

【００２１】次に、本発明のマイクロレンズアレー用金型の製造方法について図面を用いて詳細に説明する。図１は、本発明のマイクロレンズアレー用金型の製造方法の製造工程を示した模式図である。図１（ａ）は、樹脂原盤を作製する工程、図１（ｂ）は、マイクロレンズアレーのパターンを形成する工程、図１（ｃ）は、金型を作製する工程、図１（ｄ）は、金型を剥離する工程を示している。また、図２は、本発明の製造方法によって得られたマイクロレンズアレー用金型を用いてマイクロレンズアレーを成形する製造工程を示した模式図である。図２（ａ）は、マイクロレンズアレーを成形する工程、図２（ｂ）は、マイクロレンズアレーを金型から剥離する工程を示している。

【００２２】まず、ガラスやシリコン等の基板１上に、光ビーム波長に吸収帯域を有する光吸収材と形状記憶樹脂を溶剤に分散あるいは溶解させた溶液を塗布し、乾燥させて形状記憶樹脂層２を形成し、形状記憶樹脂の固定相の転移温度Ｔ２以上に加熱し、冷却することにより最初の形状を固定し記憶させ、樹脂原盤３を得る（図１（ａ））。

【００２３】次に、形状記憶樹脂層２に所定の波長の光ビーム４を照射し、可逆相の転移温度Ｔ１以上で固定相の転移温度Ｔ２以下の温度に加熱し、変形を与える。光吸収材は光ビーム４を吸収して熱を発生し、可逆相が加熱され軟化するとともに膨張する。光ビーム４を遮断すると形状記憶樹脂層２はすぐに冷却し、熱膨張によってできた半球状の隆起は急冷され、変形が保持されたまま室温に戻る。

【００２４】この動作を、所望のパターンを形成するように光ビーム４または樹脂原盤３を移動させて繰り返すことによって、所望のパターンが形成された樹脂原盤３が得られる（図１（ｂ））。

【００２５】続いて、所望のパターンが形成された樹脂原盤３のパターン表面に、スパッタリング等によりニッケル（Ｎｉ）等の導電膜を形成し、その後、Ｎｉ電鋳を行い、パターンを転写した金型５を得る（図１（ｃ））。

【００２６】そして、樹脂原盤３から金型５を剥離し（図１（ｄ））、金型５を用いて射出成形法及び２Ｐ（Photo Polymer）法等の方法により、所望の屈折率を有する樹脂またはガラスを成形し（図２（ａ））、金型５から取り外すことによりマイクロレンズアレー６を得ることができる（図２（ｂ））。

【００２７】最後に、金型５を取り外した樹脂原盤３を、オーブン等に設置し、可逆相の転移温度Ｔ１以上で固定相の転移温度Ｔ２以下の温度に加熱し、徐冷すると、残留内部応力を消すために変形が開放され、固定相が記憶した元の平滑な形状に回復し、再利用することができる。

【００２８】

【実施例】以下に、本発明のマイクロレンズアレー用金型の製造方法の実施例を詳細に示す。本実施例では、形状記憶樹脂の具体例として熱硬化性ポリウレタン樹脂を用いた場合について示すが、スチレン－ブタジエン共重合体樹脂、ポリノルボルネン樹脂等のその他の形状記憶樹脂を用いた場合も本質的に以下に示す実施例と同様である。洗浄された厚さ６ｍｍのガラス基板表面に、０．５μｍのフィルターで濾過した熱硬化性ポリウレタン樹脂溶液を、スピンコーティング法で３０００ｒｐｍで塗布し、厚さ７μｍの熱硬化性ポリウレタン樹脂層を形成し、樹脂原盤を作製した。

【００２９】ここで、熱硬化性ポリウレタン樹脂溶液は以下に示す物質を混合して作製した。また、波長７８０ｎｍのレーザ光を吸収させるために、この波長域に吸収帯を有する有機色素を光吸収材として混合した。

熱硬化性ポリウレタン樹脂
（三洋化成工業製：サンプレン、樹脂濃度３０%溶液）　　３６．９ｗｔ%

硬化剤
（三洋化成工業製：ＣＡ０７５Ｎ、イソシアネート系架橋剤）　１．２ｗｔ％
有機色素
（日本化成製：ＩＲＧ－００３）　１．２ｗｔ％
テトラクロロエタン　６０．７ｗｔ％

【００３０】以上の組成からなる樹脂原盤上に、波長７８０ｎｍのレーザ光をビーム径１５μｍに絞り込み、樹脂原盤表面での出力が３０ｍＷとなるように調整し、１ｍｓの時間照射したところ、直径約１０μｍ、高さ約３μｍの半球状のマイクロレンズパターンが形成された。そして、レーザ光を移動し、上述の動作を繰り返し、樹脂原盤上にマイクロレンズアレーのパターンを形成した。

【００３１】上記パターンを形成した樹脂原盤の表面に、Ｎｉ膜を０．１μｍの膜厚に形成し、続いて、Ｎｉ電鋳を行って、上記パターンを転写した厚さ約５ｍｍの金型を作製した。

【００３２】次に、得られた金型を用いて２Ｐ法によりマイクロレンズアレーを作製した。金型にフォトポリマーを滴下してソーダガラス基板を設置し、フォトポリマーを均一に広げた後、紫外線を照射しフォトポリマーを硬化させた。その後、金型から剥離したところ、ソーダガラス基板上に均一なマイクロレンズアレーが形成できた。

【００３３】得られたマイクロレンズアレーのマイクロレンズの大きさを原子力間顕微鏡で測定したところ、直径約１０μｍ、高さ約３μｍであり、金型から忠実に転写されていた。このマイクロレンズアレーを液晶パネルに設置したところ、画面の明るさが１．３倍になった。

【００３４】また、金型を取り外した後の樹脂原盤を、オーブン内に設置し、８０℃で１分間加熱したところ、マイクロレンズアレーのパターンが消滅し、元の平滑な状態に回復した。

【００３５】

【発明の効果】以上のように、本発明のマイクロレンズアレー用金型の製造方法では、従来の製造方法のように、ドライエッチング工程やウエットエッチング工程等の工程が不必要であるため、短時間でマイクロレンズを作製することができ、また、危険なガスや溶剤を使用する必要がない。

【００３６】さらに、本発明のマイクロレンズアレー用金型の製造方法では、基板上に有機色素等の光吸収材を含有させた熱硬化性ポリウレタン樹脂等の形状記憶樹脂層を形成した樹脂原盤をマイクロレンズアレー用原盤として用いており、一度パターンが形成された原盤を、短時間、加熱するだけで、パターンを消去することができ、さらに別のパターンを形成することができるため、１つのマイクロレンズアレー用原盤から複数のマイクロレンズアレー用金型を作製することができる。

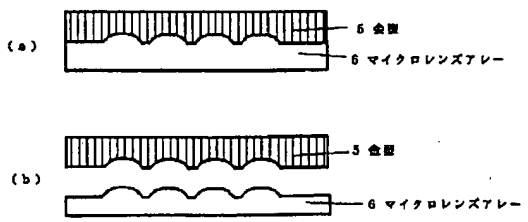
【図面の簡単な説明】

【図１】本発明のマイクロレンズアレー用金型の製造方法の製造工程を示した模式図。
（ａ）樹脂原盤を作製する工程、
（ｂ）マイクロレンズアレーのパターンを形成する工程
（ｃ）金型を作製する工程
（ｄ）金型を剥離する工程

【図２】本発明の製造方法によって得られたマイクロレンズアレー用金型を用いてマイクロレンズアレーを成形する製造工程を示した模式図。
（ａ）マイクロレンズアレーを成形する工程
（ｂ）マイクロレンズアレーを金型から剥離する工程

【符号の説明】
１　基板
２　形状記憶樹脂層
３　樹脂原盤
４　光ビーム
５　金型
６　マイクロレンズアレー

【図２】



【図１】